DOCUMENT RESUME

ED 123 223 SP 010 129

AUTHOR Aronchick, Joel; Burke, Edmund J.
TITLE Psycho-Physical Effects of Varied Rest Intervals Following Warm-Up.
NOTE 9p.; Study was conducted in partial fulfillment of the M.S. degree at Ithaca College under the direction of Edmund J. Burke (Ithaca College, Ithaca, New York)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Anxiety; Exercise (Physiology); *Heart Rate; *Physical Fitness; Psychological Tests; Research
IDENTIFIERS *Astrand Rhyming Bicycle Test; *Physical Rate

ABSTRACT

This study assessed the effects of varied rest intervals following a five-minute warm-up upon subsequent ratings of perceived exertion (RPE), heart rate (HR), and state anxiety during an exercise period. The subjects were 16 male college students. Each subject was tested under four experimental conditions following a five-minute warm-up on a bicycle ergometer at 75 percent of maximum heart rate (HRmax). Rest intervals of one minute, five minutes, 10 minutes, and no rest preceded a progressively increasing eight-minute exercise period on a bicycle ergometer. Ratings of RPE, HR, and state anxiety were obtained at 1000, 1200, 1400, and 1600 kilopond-meters (KPM) per minute during each of the experimental conditions. An analysis of variance, four by four by four factorial design with repeated measures on both factors were used to determine if significant differences existed in state anxiety levels between the experimental conditions. Intraclass correlation coefficients revealed that the reliability for HR and RPE was extremely high. It was found that no significant difference existed between the four experimental conditions for perceived exertion, heart rate, and state anxiety. RPE was found to be a good predictor of physiological strain as indicated by HR. (Author/SK)

PSYCHO-PHYSICAL EFFECTS OF VARIED REST INTERVALS FOLLOWING WARM-UP

Joel Aronchick
Edmund J. Burke

1. The possible beneficial effects of warm-up on subsequent performance may be explained by several physiological principles. Physical performance should be enhanced when undertaken in a steady state as opposed to the oxygen deficit stage of exercise. In addition, elevated core temperature allows for higher metabollic processes in the muscle cell, in improved efficiency of certain enzymes and greater oxygen disassociation by hemoglobin (1).

2. A considerable number of studies have been conducted concerning the effect of warm-up prior to exercise on subsequent physical performance. While studies have shown that warm-up is beneficial (7, 11, 19, 26), a similar number have shown no significant differences in physical performance (13, 16, 22, 25). Much of the reason for the inconsistent findings in the research, may be attributed to the confounding effect of uncontrolled antecedent variables, e.g., the amount of work done during warm-up, the duration of warm-up, the intensity of warm-up, the various types of warm-up, and the rest intervals utilized between the warm-up period and performance. Additional factors which may account for differences include age, sex, physical condition, skill level, attitude toward warm-up, and other psychological variables. Franks (9) concludes there is some direct evidence to indicate that warm-up is more beneficial to college aged, trained persons with a positive attitude towards warm-up.

3. Several studies have examined the effects of rest intervals on subsequent physical performance. Blohm (4) found improved performance in the mile

---

Joel Aronchick teaches at Ithaca High School in Ithaca, New York, 14850. Edmund J. Burke is assistant professor in the School of HPER, Ithaca College, Ithaca, New York. This study was conducted in partial fulfillment of the M.S. degree at Ithaca College under the direction of Edmund J. Burke.

run resulting from warm-up followed by rest intervals of six and 14 minutes as opposed to 22 minutes. Using rest intervals of one, four and 10 minutes, Hutterly (12) found no significant difference between the running times of the 440- yard dash. Miller (18) reported that rest intervals of five and eight minutes had no significant effect on measures of heart rate, $\dot{V}O_2$ max, or on an endurnace run. Testing 66 boy scouts, ages 12 to 14, on a bicycle ergometer, Schutz (21) found that rest intervals of one, six, and 11 minutes had no significant effect on velocity, acceleration, or muscular performance. Scogin (22) reported that both a moderate and heavy warm-up followed by rest intervals of two, 15, or 30 minutes had no significant effect on swimming performance.

4. The linear relationship between RPE and HR has been well established during both bicycle and treadmill ergometry (6, 23). This relationship has generated speculation about the metabolic parameters which may serve as stimuli for perceived exertion. Catecholamine excretion, respiratory volume and frequency, and cardiac frequency have been cited (2, 6). Borg and Linderholm (6) reported that HR and REP increased in a linear fashion with increasing work loads while testing 61 lumber workers, ages 27 to 63. Gamberale (10) found the same linear relationship between RPE and HR during exercise on a bicycle ergometer, lifting weight, and pushing a wheelbarrow. Ekblom and Goldbarg (8) found that RPE obtained on a bicycle ergometer were not significantly different following the blockade of the autonomic nervous system. RPE was not significantly different in either cycling, running, or swimming for a given oxygen uptake. Bar-Or et al. (3) reported that RPE on bicycle ergometer and treadmill tests were closely related to submaximal heart rate, irrespective of the conditioning or adiposity of the subjects.

5. Research conducted concerning the influence of state anxiety on motor performance has been lacking in clarity and precision due to the failure in

clearly defining state anxiety and related terms as empirical and theoretical constructs. According to Martens (15), the problem with testing state anxiety using the Inverted-U Hypothesis is the inability to measure points precisely along the axiety continuum.

6. No research has been found which has investigated the effects of different rest intervals on psychological variables such as perceived exertion and state anxiety. The purpose of this study was to assess the effects of varied rest intervals following warm-up on subsequent measurements of heart rate, perceived exertion and state anxiety.

METHOD

7. Work tests were administered to male college students on five different testing sessions. Work testing was conducted with the use of a Quinton electronically braked bicycle ergometer. All tests involving the measurement of heart rate were conducted using bipolar chest electrodes connected to a Quinton electro-cardiogram chart recorder. On the first day of testing, subjects were administered the Astrand-Rhyming bicycle test as described by Astrand and Rodahl (1). Initially, forty students ranging in age from 18 to 27 years volunteered for the study. In an effort to limit the study to subjects within a given level of aerobic power, only subjects with predicted VO_2 max of 51 ml/kg/min were utilized on subsequent days of testing. For the 16 subjects who qualified for the study, additional work loads at 200 KPM increments were given until the subject reached a self-imposed maximum. The Highest heart rate obtined was used as the subject's maximum heart rate (HRmax).

8. In an attempt to control for sequential effects, the order of rest intervals between warm-up and a progressive work test were varied between subjects for days two through five. The warm-up was selected with the intention

of providing the necessary time and intensity needed to reach a steady state while increasing muscle temperature. Astrand and Rodahl (1) have hypothesized that warm-up consisting of five minutes of "light to moderate exercise" may reduce time in the 400 yard dash by three seconds. Warm-up was carried on for five minutes with the subject pedalling at 60 rpm while the workload was adjusted to achieve an intensity of 75 percent of HR max.

9. Rest intervals were selected based on physiological and external validity considerations. It was held that most of the physiological benefits of warm-up would be dissipated beyond ten minutes. In many sports situations, the time between the formal warm-up session and the actual competition is commonly less than ten minutes. Thus, rest intervals were set at one, five, ten and no minutes. The eight minute work test consisted of progressively increasing work loads beginning with 1000 kpm/min and increasing by 200 every two minutes. RPE and HR were recorded during the last five seconds of each work load. Measures of state anxiety as described by Speilberger (26) were recorded at: five seconds; 30 seconds; one minute; one and one-half minute; and two minutes of each work load.

10. An analysis of variance, four by four factorial design with repeated measures on both factors, was used to determine if differences existed between the four rest intervals and work loads fo HR and RPE. An analysis of variance, treatment by subjects design, was used to test for the presence of a significant difference between rest intervals for state anxiety.

RESULTS AND DISCUSSION

11. The 16 male subjects involved in the experimental treatments had an age of $\overline{X}$ = 21.00 ± 2.42 years; height of 177.95 ± 5.76 cm; weight of 77.13 ± 6.97 kg; $\dot{V}O_2$ max of 54.44 ± 4.19 ml/kg/min; HR max of 174.56 ± 8.59. Pearson

product moment correlations were computed between HR and RPE across work loads for each of the rest intervals as follows: one minute, r = .67; five minutes, r = .74; 10 minutes, r = .76; no minutes, r = .59; and all conditions, r = .69. These correlations are comparable or lower than those reported by Borg (5). Kroll (14) has recommended intraclass correlation as a preferred technique in determining reliability. As can be seen in Table 1, under all conditions, reliability for both heart rate and perceived exertion was high.

12. F ratios obtained across days for HR and RPE respectively, were: F = 2.10 and F = .04. Neither were significant at the .05 level. As expected, highly significant F ratios ($p < .001$) were obtained between work loads for both heart rate and perceived exertion, reflecting the ability fo these parameters to measure increases in physical work output. No significant interactions were obtained.

13. Mean HR's were highest for the one minute and no rest conditions while $\overline{X}$ RPE were lowest under these conditions. It is possible to speculate that the higher heart rates during the early munutes of the work test are a reflection of quicker reaction of the circulatory system in meeting the demands of muscular work with a consequent reduction in exertion. As the rest interval increases the HR is lower and the effort may be greater. Although RPE may not have the needed sensitivity to measure these small differences, they may indeed make a difference in physical performance.

14. The grand mean of state anxiety for all experimental conditions was found to be 38.75. This is similar to a mean score of 36.36 obtained by Spieberger (26) in a group of male undergraduate students. ANOVA revealed no significant difference between the four experimental conditions. It appears that the subjects were representative of the general male undergraduate college population and that state anxiety was unaffected by exercise under the four experimental conditions.

REFERENCES

1. Astrand, P.O. and Rodahl, K. Textbook of Work Physiology. New York, N.Y.: McGraw-Hill Co., 1970.

2. Bakers, J.H. and Tenney, S.M. "The perception of some sensations associated with breathing." Respiratory Physiology 10:85-92, 1970.

3. Bar-Or, O.; Skinner, J.S.; Buskirk, E.R.; and Borg, G.V. "Physiological and perceptual indicators of physical stress in 41 to 60 year-old men who vary in conditioning levels and in body fatness." Medicine and Science in Sports 4:96-100, 1972.

4. Blohm, F. "Running endurance performance as affected by warm-up and varied rest intervals." Unpublished doctoral dissertation, University of Arkansas, 1969.

5. Borg. G.A. "Perceived exertion: a note on 'history' and methods." Medicine and Science in Sports 5:90-93, 1973.

6. Borg, G.V. and Linderholm. "Exercise performance and perceived exertion in patients with coronary insufficiency, arterial hypertension, and vasoregulatory asthenia." Acta Medica Scandinavica 187:17-26, 1970.

7. Carlile, F. "Effect of preliminary passive warming on swimming performance." Research Quarterly 27:143-151, 1956.

8. Ekblom, B. and Goldbarg, A.N. "The influence of physical training and other factors on the subjective rating of perceived exertion." Acta Physiologica Scandinavica 83:399-406, 1971.

9. Franks, B.D. "Physical Warm-up." In: Morgan, W.P.(ed.) Ergogenic Aids and Muscular Performance. New York: Academic Press, 1972.

10. Gamberale, F. "Perceived exertion, heart rate, oxygen uptake, and blood lactate in different work operations. Ergonomics 15:545-554, 1972.

11. Grodjinovsky, A., and Mage, J.R. Effect of Warm-up on running performence. Research Quarterly 41:116-119, 1970.

12. Hutterly, W.U. "Effects of varied intervals of rest between warm-up and performance on 440-yard dash times." Unpublished master's thesis, North Texas State University, 1967.

13. Karpovich, P.V. and Hale, C.J. "Effect of warming-up upon physical performance." Journal of the American Medical Association 162:1117-1117, 1956.

14. Kroll, W. "A note on the coefficient of intraclass correlation as an estimate of reliability." Research Quarterly 33:313-316, 1962.

15. Martens, R. "Arousal and motor performance." In: Wilmore, J.H.(ed.) Exercise and Sport Science Reviews Vol. 2, New York, N.Y.: Academic Press, 1974.

16. Martens, R. "Trait and state anxiety." In: Morgan, W.P. (ed.) Ergogenic Aids and Muscular Performance. New York, N.Y.; Academic Press, 1972.

17. Mathews, D.K. and Snyder, A.H. "Effect of warm-up on the 440-yard dash." Research Quarterly 30:446-451, 1959.

18. Miller, R.W. "The effect of varied rest intervals following vigorous warm-up on physical and physiological performance." Unpublished master's thesis, University of Minnesota, 1971.

19. Muido, L. "The influence of body temperature on performance in swimming." Acta Physiologica Scandinavica 12:102-109, 1946.

20. Noble, B.J. and Borg, G.V. "Perceived exertion during walking and running." In: The Proceedings of the International Congress of Applied Psychology 1:387-392, 1972.

21. Schutz, R.W. "The effects of various warm-up procedures on acceleration, velocity and muscular endurance." Unpublished master's thesis, University of Alberta, 1966.

22. Scogin, H.D. "A comparison of swimming performanced following selected intensities of warm-up with varied rest intervals." Unpublished doctoral dissertation, University of Arkansas, 1969.

23. Skinner, J.S.; Borg, G.V.; and Buskirk, E.R. "Physiological and perceptual reactions to exertion of young men differing in activity and body size." In: Franks, B.D. (ed.) Exercise and Fitness. Chicago, Illinois: The Athletic Institute, 1969.

24. Skubik, U. and Hodgkins, J. "Effect of warm-up on speed, strength and accuracy." Research Quarterly 28:147-152, 1957.

25. Spielberger, C.D. "Notes and comments: trait-state anxiety and motor behavior." Journal of Motor Behavior 3:265-279, 1971.

26. Thompson, H. "Effect of warm-up upon physical performance in selected activities." Research Quarterly 29:231-246, 1958.

TABLE 1. MEANS, STANDARD DEVIATIONS AND INTRACLASS CORRELATIONS FOR HEART RATE PERCEIVED EXERTION AND STATE ANXIETY ACROSS FOUR REST INTERVALS AND WORK LOADS (N=16).

		ONE MINUTE REST INTERVAL		FIVE MINUTE REST INTERVAL		TEN MINUTE REST INTERVAL		NO REST		RELIABILITY*
WORK LOAD		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
1000 kpm/min.	RPE	12.06	1.61	12.38	.72	12.25	1.34	12.19	1.38	.98
	HR	138.50	9.97	137.69	8.47	135.56	7.77	138.81	8.34	.99
1200 kpm/min.	RPE	13.75	1.65	14.13	1.20	14.00	1.32	14.06	1.34	.97
	HR	147.69	11.07	144.69	9.24	145.75	9.80	146.94	9.04	.99
1400 kpm/min.	RPE	16.88	1.71	16.31	1.40	16.69	1.30	16.50	1.55	.99
	HR	161.31	12.21	158.88	10.45	160.56	10.06	161.19	9.22	.99
1600 kpm/min.	RPE	18.19	1.38	18.31	1.70	18.19	1.42	18.13	1.78	.99
	HR	172.44	10.18	169.06	9.90	170.69	9.28	170.69	10.00	.99
COMBINED WORKLOADS	STATE ANXIETY	39.44	9.76	39.19	8.01	37.81	8.44	38.56	9.69	.99

*Intraclass Correlation